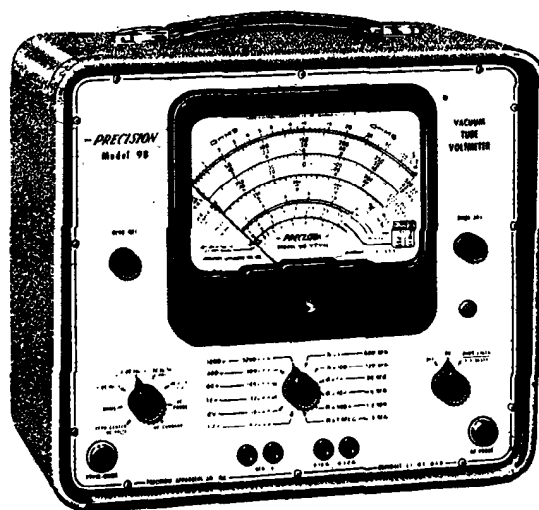


OPERATING INSTRUCTIONS FOR

PRECISION

MODEL



98

VACUUM TUBE VOLTMETER



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MODEL 98
VACUUM TUBE VOLTMETER

THE PRECISION MODEL 98 IS A MODERN STREAMLINED, WIDE RANGE VTVM-OHMMETER, SPECIFICALLY ENGINEERED FOR ELECTRONIC CIRCUIT CHECKING IN THE LABORATORY, ON THE PRODUCTION LINE AND FOR GENERAL SERVICE-MAINTENANCE.

THE MODEL 98 INCORPORATES MANY ADVANCED FEATURES AND FUNCTIONS WHICH ARE THE RESULT OF EXTENSIVE STUDY AND INVESTIGATION OF ACTUAL FIELD REQUIREMENTS FOR AN EFFICIENT, RELIABLE AND STABLE ELECTRONIC VOLT-OHMMEETER. OF PARTICULAR NOTE IS THE ESPECIALLY ENGINEERED PEAK-TO-PEAK VOLTAGE TESTING FUNCTION WHICH AFFORDS A NEW HIGH IN P-P READING ACCURACY OF PULSED WAVE-FORMS AS ENCOUNTERED IN TV AND SIMILAR APPLICATIONS.

RANGES, SPECIFICATIONS AND SPECIAL FEATURES

6 TRUE ZERO-CENTER DC VTVM RANGES:

CONSTANT 26 $\frac{2}{3}$ MEGOHMS INPUT RESISTANCE

$\pm 1.2V$	$\pm 6V$	$\pm 12V$	$\pm 60V$	$\pm 300V$	$\pm 1200V$
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6 LEFT-HAND-ZERO (+) POSITIVE DC VTVM RANGES

CONSTANT 135 MEGOHMS INPUT RESISTANCE					
+1.2V	+6V	+12V	+60V	+300V	+1200V

6 LEFT-HAND-ZERO (-) NEGATIVE DC VTVM RANGES:

CONSTANT	135	MEGDHMS INPUT RESISTANCE				
-1.2V	-6V	-12V	-60V	-300V	-1200V	

6 HIGH IMPEDANCE AC RMS VTVM RANGES:

1.2V	6V	12V	60V	300V	1200V
INPUT CHARACTERISTICS:			UP	TD	
			60V RANGE:		3 MEGOHMS 90 MMF
			300V RANGE:		1 MEGOHM 70 MMF
			1200V RANGE:		4 MEGOHMS 60 MMF

6 HIGH IMPEDANCE AC PEAK-TO-PEAK VTVM RANGES:

3.2V	16V	32V	160V	800V	3200V
INPUT CHARACTERISTICS:					
UP TO 160V RANGE:			6 MEGOHMS	90 MMF	
800V RANGE:			1 MEGOHM	70 MMF	
3200V RANGE:			4 MEGOHMS	60 MMF	

6 ELECTRONIC OHMMETER RANGES: (10 OHMS CENTER SCALE):

Rx1 Rx100 Rx1K Rx10K Rx100K Rx1 MEGOHM

8 DC CURRENT RANGES:

.3MA 1.2MA 6MA. 30MA. 120MA. 600MA. 1.2 AMPS 12 AMPS

5 SPECIAL HIGH FREQUENCY AC RMS VTVM PROBE RANGES:

1.2V 6V 12V 60V 300V

FREQUENCY RESPONSE GOOD TO 300 MEGACYCLES. EFFECTIVE INPUT CAPACITY APPROXIMATELY 5 MMF. (REQUIRES OPTIONAL PRECISION RF-10A HF PROBE).

6 DB RANGES:

-20 TO +63 DB IN 6 DVERLAPPING STEPS.

ONE UNIVERSAL COAXIAL CABLE WITH PROBE SERVES ALL AC VTVM, DC VTVM AND OHMMETER FUNCTIONS OTHER THAN HF FUNCTION. TEST LEADS PROVIDED FOR DC CURRENT MEASUREMENT.

TRUE ZERO CENTER DC VTVM PROVIDES IN ONE OPERATION, BOTH MAGNITUDE AND POLARITY OF VOLTAGE, WITHOUT REVERSAL OF TEST PRODS. IDEAL FOR FM DISCRIMINATOR ADJUSTMENTS, BIAS MEASUREMENTS AND "BLIND TESTS" WHERE POLARITY AND VOLTAGE ARE UNKNOWN.

HIGH SENSITIVITY, FULL-BRIDGE VTVM CIRCUIT AFFORDS UTMOST RELIABILITY AND ACCURACY.

DUO-BALANCED, ELECTRONIC-BRIDGE OHMMETER PROVIDES INDEPENDENT END OF SCALE ELECTRICAL ADJUSTMENTS. THIS HELPS ASSURE HIGHEST ACCURACY THROUGHOUT ENTIRE SCALE LENGTH.

SPECIAL HIGH IMPEDANCE PEAK-TO-PEAK CIRCUIT DESIGN PROVIDES OPTIMUM ACCURACY OF READINGS OF NARROW PULSE-TYPE WAVEFORMS.

PEAK-TO-PEAK "RE-SET" SWITCH POSITION FOR RAPID "ZERO" RETURN OF SPECIAL ELECTRONICALLY DAMPED TEST CIRCUIT.

VOLTAGE REGULATION OF ALL ZERO-CENTER VTVM RANGES ASSURES READING STABILITY NOT ASSOCIATED WITH USUAL "ARBITRARY" ZERO CENTER VTVM'S.

FULL VISION 7" RUGGED FACE METER: 200 MICROAMPERES SENSITIVITY, 2% ACCURACY. DOUBLE-JEWELLED D'ARSONVAL MOVEMENT. MANUFACTURED BY PRECISION'S OWN MODERN METER PLANT.

1% MULTIPLIERS AND SHUNTS. WIRE-WOUND AND DEPOSITED-FILM TYPES.

EACH INSTRUMENT INDIVIDUALLY TESTED AND CALIBRATED AGAINST LABORATORY STANDARDS FOR STRICT ADHERENCE TO SPECIFIED TOLERANCES.

INTRODUCTION

THE MODEL 98 VTVM HAS BEEN CAREFULLY AND RUGGEDLY DESIGNED TO PROVIDE LONG-LIVED, TROUBLE-FREE PERFORMANCE. REASONABLE CARE IN THE USE AND APPLICATION OF THIS INSTRUMENT WILL ASSURE THE HIGH ACCURACY AND DEPENDABILITY THAT IS DESIGNED AND BUILT INTO ALL PRECISION TEST EQUIPMENT.

THE VTVM CIRCUIT OF THE MODEL 98 PROVIDES AUTOMATIC, ELECTRONIC PROTECTION TO THE METER-MOVEMENT INASMUCH AS THE BRIDGE-CIRCUIT LIMITS THE MAXIMUM AMOUNT OF CURRENT WHICH CAN BE DELIVERED TO THE METER-MOVEMENT. THE MODEL 98 IS THEREFORE MUCH LESS SUSCEPTIBLE TO METER OVERLOAD AND BURN-OUT AS COMPARED TO NON-ELECTRONIC TYPE VOLT-OHMMETERS. NEVERTHELESS, IT IS ALWAYS GOOD INSTRUMENT PRACTICE TO OBSERVE THE FOLLOWING PRECAUTION WHEN USING ANY MULTI-RANGE VOLTMETER:-

"BEFORE ATTEMPTING TO MEASURE ANY UNKNOWN VALUE OF VOLTAGE, FIRST SET THE RANGE SELECTOR SWITCH TO THE HIGHEST VOLTAGE RANGE. THEN APPLY THE UNKNOWN VOLTAGE. REDUCE THE RANGE SELECTOR SWITCH SETTING, ONE RANGE AT A TIME, UNTIL THE PROPER RANGE IS SELECTED AS WILL PROVIDE A GOOD DEFLECTION OF THE METER."

THIS INSTRUCTION MANUAL IS INTENDED TO EXPLICITLY DETAIL ALL OPERATING FUNCTIONS OF THE MODEL 98. IT IS STRONGLY SUGGESTED THEREFORE THAT THE OPERATOR CAREFULLY READ THE COMPLETE MANUAL BEFORE ACTUALLY APPLYING THE INSTRUMENT TO CIRCUIT TESTING.

FUNCTIONS OF PANEL COMPONENTS

"ZERO ADJ." CONTROL: PERMITS ELECTRICAL ZERO ADJUSTMENT OF ALL ELECTRONIC FUNCTIONS. (DC CURRENT IS A NON-ELECTRONIC FUNCTION.) (MECHANICAL ZERO ADJUSTMENT OF ALL FUNCTIONS, WITH POWER "OFF", IS MADE USING THE BAKELITE SCREW-HEAD IN THE LOWER CENTER OF THE METER CASE.)

"OHMS ADJ." CONTROL: PERMITS ELECTRICAL ADJUSTMENT AT INFINITY (∞) MARK ON ALL "OHMS" RANGES.

FUNCTION SWITCH (LEFT HAND SIDE): PROVIDES FOR SIMPLE AND DISTINCT SELECTION OF THE DESIRED INSTRUMENT FUNCTION.

RANGE SWITCH (CENTER): SELECTS ALL INSTRUMENT RANGES EXCEPT 1.2A AND 12A.

EACH POSITION OF THE SWITCH SERVES A MULTIPLE PURPOSE DEPENDENT UPON THE SETTING OF THE FUNCTION SWITCH.

LINE SWITCH (RIGHT HAND SIDE)

"OFF" POSITION: POWER IS OFF. DC CURRENT CAN BE MEASURED, BUT ALL OTHER FUNCTIONS ARE INOPERATIVE.

"ON" POSITION: POWER IS ON. ALL FUNCTIONS (INCLUDING DC CURRENT) ARE OPERATIVE.

"OHMS CHECK, P-P RESET" POSITION: WITH THE INSTRUMENT SET UP TO MEASURE OHMS, THIS SWITCH POSITION CHECKS THE ZERO OHMS SETTING WITHOUT THE NECESSITY OF SHORTING THE VTVM PROBE LEADS. WITH THE INSTRUMENT SET UP TO READ AC PEAK-TO-PEAK VOLTS THIS POSITION MAY BE USED BY THE OPERATOR TO SPEED UP THE RETURN OF THE POINTER TO ZERO AFTER A MEASUREMENT IS MADE.

"VTVM-OHMS" PANEL CONNECTOR (LOWER LEFT): SINGLE POLE CONNECTOR FOR PRECISION AC-DC VTVM PROBE SUPPLIED WITH INSTRUMENT. USED FOR ALL FUNCTIONS EXCEPT DC CURRENT AND HF PROBE TESTS.

"HF PROBE" CONNECTOR (LOWER RIGHT): 2 POLE CONNECTOR FOR USE WITH OPTIONAL PRECISION RF-10A HIGH FREQUENCY PROBE WHEN THE FUNCTION SWITCH IS SET TO "HF PROBE" POSITION.

DC CURRENT JACKS (LOWER CENTER): FOR USE WITH STANDARD TEST LEADS SUPPLIED WITH INSTRUMENT. (SEE "DC CURRENT" OPERATING INSTRUCTIONS.)

SET UP PROCEDURE

- A. TO EMPLOY THE ELECTRONIC FUNCTIONS OF THE MODEL 98, THE LINE PLUG MUST BE CONNECTED TO A 110-120 VOLT 50-60 CYCLES AC SOURCE. (NEVER CONNECT THE 98 TO ANY OTHER POWER SOURCE UNLESS IT HAS BEEN SPECIFICALLY SUPPLIED AND IDENTIFIED FOR ANOTHER VOLTAGE AND/OR FREQUENCY.)
- B. SET THE MODEL 98 IN THE POSITION YOU PREFER. CHECK THE MECHANICAL ZERO SETTING OF THE METER POINTER WITH THE LINE SWITCH IN THE "OFF" POSITION. IF THE POINTER DOES NOT LINE UP WITH THE LEFT HAND ZERO CALIBRATIONS, RE-SET IT BY ROTATING THE BAKELITE SCREW HEAD ON THE METER CASE.
- C. ROTATE THE LINE SWITCH TO THE "ON" POSITION. ALLOW A WARM-UP PERIOD OF APPROXIMATELY 3 MINUTES.

NOTE: THE DC CURRENT FACILITIES OF THE 98 ARE INDEPENDENT OF THE VTVM FUNCTIONS OF THE INSTRUMENT AND CAN BE USED WITH THE POWER TO THE 98 "ON" OR "OFF".

OPERATING INSTRUCTIONS1. ZERO CENTER DC VOLTS

SET THE SLIDE SWITCH OF THE AC-DC PROBE TO "DC" POSITION.
 SET THE FUNCTION SWITCH TO "ZERO CENTER" POSITION.
 SELECT THE DESIRED RANGE ON THE RANGE SWITCH.

NOTE: IT IS ALWAYS GOOD PRACTICE TO SET THE RANGE SWITCH TO THE HIGHEST RANGE FIRST WHEN AN UNKNOWN VOLTAGE IS TO BE MEASURED. THEN REDUCE THE RANGE SELECTOR A RANGE AT A TIME UNTIL SATISFACTORY DEFLECTION IS OBTAINED.

WITH THE PROBE'S ALLIGATOR CLIP TEMPORARILY SHORTED TO THE PROBE TIP, TURN THE "ZERO ADJ." CONTROL TO SET THE METER POINTER TO THE LARGE ZERO IN THE MIDDLE OF THE BLUE "ZERO CENTER DC" ARC. DISCONNECT CLIP FROM TIP.

NOTE: WHEN THE ALLIGATOR CLIP IS DISCONNECTED FROM THE PROBE TIP, THE METER POINTER MAY DEFLECT A BIT FROM THE TRUE CENTER SETTING. THIS SHIFT (IF IT OCCURS) IS ATTRIBUTABLE TO MINUTE GRID CURRENT FLOWING IN THE HIGH INPUT RESISTANCE AND WILL NOT AFFECT THE ACCURACY OF THE VOLTAGE READINGS.

ATTACH THE ALLIGATOR CLIP TO ONE TERMINAL OF THE CIRCUIT UNDER TEST (USUALLY TO GROUND OR CHASSIS). TOUCH THE PROBE TIP TO THE OTHER TERMINAL OF THE CIRCUIT. THE METER WILL INSTANTLY INDICATE BOTH MAGNITUDE AND POLARITY OF THE VOLTAGE. READINGS TO THE LEFT OF ZERO CENTER ARE NEGATIVE, TO THE RIGHT OF ZERO CENTER, POSITIVE.

CAUTION: DO NOT CONNECT THE METAL ALLIGATOR CLIP TO ANY HIGH VOLTAGE POINTS WHILE THERE IS POWER ON IN THE CIRCUIT BEING MEASURED. SHUT POWER OFF IN THE CIRCUIT BEING MEASURED BEFORE CONNECTING OR DISCONNECTING THE CLIP FROM ANY HIGH VOLTAGE POINTS.

READ ALL ZERO CENTER DC VOLTAGES ON THE BLUE "ZERO CENTER DC" ARC AS FOLLOWS:

0 TO $\pm 1.2V$ DC, READ ON THE 12 SCALE AND DIVIDE BY 10
 0 TO $\pm 6V$ DC, READ ON THE 60 SCALE AND DIVIDE BY 10
 0 TO $\pm 12V$ DC, READ DIRECTLY ON 12 SCALE
 0 TO $\pm 60V$ DC, READ DIRECTLY ON 60 SCALE
 0 TO $\pm 300V$ DC, READ DIRECTLY ON 300 SCALE
 0 TO $\pm 1200V$ DC, READ ON THE 12 SCALE AND MULTIPLY BY 100

2. LEFT-HAND ZERO DC VOLTS

WITH THE FUNCTION SWITCH SET TO EITHER THE "-DC VOLTS" OR "+DC VOLTS" POSITION, THE 98 OPERATES EXACTLY THE SAME AS ALREADY DESCRIBED FOR "ZERO CENTER" EXCEPT THAT READINGS ARE TAKEN ON THE BLACK "DC AND RMS" SCALES. USE THE "+DC" FUNCTION WHEN THE POLARITY OF THE VOLTAGE TO BE MEASURED IS POSITIVE. USE "-DC" WHEN THE POLARITY IS EXPECTED TO BE NEGATIVE. (IF THE POLARITY IS UNKNOWN, IT IS WISE TO USE THE ZERO CENTER FUNCTION FIRST)

THE RANGE OF THE LEFT HAND ZERO DC VOLTAGE MEASUREMENTS MAY BE EXTENDED TO 60,000 VOLTS BY USE OF THE OPTIONAL TV-8 HIGH VOLTAGE PROBE. TO USE THE ACCESSORY TV-8 PROBE, DISCONNECT THE AC-DC PROBE OF THE MODEL 98 AND INSERT THE CABLE CONNECTOR OF THE TV-8 INTO THE "VTVM-OHMS" PANEL CONNECTOR.

THE TV-8 PROBE MULTIPLIES ALL LEFT HAND ZERO DC VOLTAGE RANGES OF THE MODEL 98 BY A FACTOR OF 100. FOR A 6000 VOLTS RANGE, SET THE RANGE SWITCH TO "60V". FOR A 30,000 RANGE, SET THE RANGE SWITCH TO "300V" WITH RANGE SWITCH SET TO "1200V", THE HIGH VOLTAGE PROBE MAY BE USED FOR MEASUREMENTS UP TO BUT NOT EXCEEDING 60,000 VOLTS. VOLTAGES ARE READ AS FOLLOWS:

0 TO 6000V DC READ ON 60 SCALE AND MULTIPLY BY 100

0 TO 30,000V DC READ ON 300 SCALE AND MULTIPLY BY 100

0 TO 60,000V DC READ ON 1200 SCALE AND MULTIPLY BY 100

CAUTION: OBSERVE ALL HIGH VOLTAGE PRECAUTIONS DETAILED IN THE INSTRUCTION BOOK ACCOMPANYING SERIES TV-8 HIGH VOLTAGE MULTIPLIER PROBE.

3. RESISTANCE MEASUREMENTS

SET THE SLIDE SWITCH OF THE AC-DC PROBE TO "AC-OHMS" POSITION.

SET THE FUNCTION SWITCH TO THE "OHMS" POSITION.

SET THE RANGE SWITCH TO THE DESIRED RESISTANCE RANGE.

SHORT THE INPUT TO THE OHMMETER BY TURNING THE LINE SWITCH TO "OHMS CHECK" POSITION. WITH THE LINE SWITCH HELD IN "OHMS CHECK" POSITION, ROTATE THE "ZERO ADJ." KNOB UNTIL THE METER POINTER COINCIDES WITH THE ZERO CALIBRATION ON THE "OHMS" SCALE.

NOTE: THE "OHMS CHECK" POSITION SHORTS THE INPUT TO THE OHMMETER JUST AS THOUGH THE PROBE LEADS WERE SHORTED TOGETHER. THEREFORE THE OPERATOR MAY USE THE SHORT CHECK SWITCH OR HE MAY SHORT THE PROBE LEADS TOGETHER, AS HE WISHES.

NOTE FURTHER THAT THE "OHMS CHECK" POSITION HAS A BUILT-IN RETURN SPRING WHICH AUTOMATICALLY OPENS THE SHORTED INPUT WHEN RELEASED.

WITH THE AC-DC PROBE LEADS OPEN-CIRCUITED, RELEASE THE "OHMS CHECK" SWITCH AND ROTATE THE "OHMS ADJ." KNOB UNTIL THE METER POINTER LINES UP WITH THE " ∞ " MARK (FULL SCALE.)

CAUTION: ALWAYS FIRST DISENGAGE AT LEAST ONE END OF THE COMPONENT WHOSE RESISTANCE IS TO BE CHECKED FROM THE CIRCUIT BEFORE MAKING RESISTANCE MEASUREMENTS. OTHERWISE THE CIRCUIT INVOLVED MIGHT VERY WELL SHUNT THE RESISTANCE BEING MEASURED. THIS WOULD REDUCE THE TRUE READING BY AN AMOUNT PROPORTIONATE TO THE RESISTANCE OF THE INCLUDED SHUNT NETWORK.

SPECIAL PRECAUTION: BE SURE THAT ABSOLUTELY NO VOLTAGE IS PRESENT AT THE RESISTANCE UNDER TEST. THE SUREST METHOD IS TO COMPLETELY DISCONNECT THE COMPONENT UNDER TEST FROM ANY AND ALL SOURCES OF POWER, INCLUDING GROUNDS.

ATTACH THE ALLIGATOR CLIP TO ONE END OF THE COMPONENT TO BE TESTED, APPLY THE PROBE TIP TO THE OTHER END. READ ALL RESISTANCE MEASUREMENTS ON THE "OHMS" ARC AS FOLLOWS:

"Rx1" RANGE: READ OHMS SCALE DIRECTLY
(1000 OHMS = FULL SCALE; CENTER SCALE = 10 OHMS)

"Rx100" RANGE: MULTIPLY ALL READINGS BY 100
(100,000 OHMS = FULL SCALE; CENTER SCALE = 1000 OHMS)

"Rx1K" RANGE: MULTIPLY ALL READING BY 1000
(1 MEGOHM = FULL SCALE; CENTER SCALE = 10,000 OHMS)

"Rx10K" RANGE: MULTIPLY ALL READINGS BY 10,000
(10 MEGOHMS = FULL SCALE; CENTER SCALE = 100,000 OHMS)

"Rx100K" RANGE: MULTIPLY ALL READINGS BY 100,000
(100 MEGOHMS = FULL SCALE; CENTER SCALE = 1 MEGOHM)

"Rx1 Meg" RANGE: MULTIPLY ALL READINGS BY 1,000,000
(1000 MEGOHMS = FULL SCALE; CENTER SCALE = 10 MEGOHMS)

A SINGLE $1\frac{1}{2}$ VOLT BATTERY (EVEREADY D-99 OR EQUAL) IS EMPLOYED FOR ALL OHMMETER RANGES. A STANDARD FLASHLIGHT CELL (EVEREADY 950 OR EQUAL) CAN BE USED IN PLACE OF THE D-99 CELL. HOWEVER LONGER USEFUL LIFE IS TO BE EXPECTED FROM THE D-99.

THE OHMMETER BATTERY SHOULD BE REPLACED WHENEVER FULL SCALE (∞) DEFLECTION CANNOT BE OBTAINED WITH THE TEST LEADS OPEN AND WITH "OHMS ADJ." CONTROL ROTATED FULLY TO THE RIGHT.

NOTE: THE OHMMETER CIRCUIT CONNECTIONS ARE SUCH THAT THE PROBE TIP POLARITY IS POSITIVE; THE ALLIGATOR CLIP POLARITY, NEGATIVE.

CAUTION: IT IS GOOD PRACTICE TO MAKE SURE THAT THE PROBE LEADS ARE NOT LEFT SHORTED TOGETHER AFTER USING THE OHMS FUNCTION, OTHERWISE CONTINUOUS CURRENT WOULD BE DRAWN FROM THE BATTERY. THIS APPLIES ONLY WHEN THE FUNCTION SWITCH IS IN THE "OHMS" POSITION.

4. AC RMS VOLTAGE MEASUREMENTS

ALL AC RMS VOLTAGE MEASUREMENTS ARE MADE UTILIZING A BUILT-IN HIGH IMPEDANCE POSITIVE-PEAK-RESPONSE SHUNT DIODE CIRCUIT.

NOTE: ALL AC RMS SCALE READINGS ARE IN TERMS OF RMS OF SINUSOIDAL VOLTAGE.
ACCURACY AND RESPONSE SPECIFICATIONS DO NOT APPLY WHEN NON-SINUSOIDAL VOLTAGES ARE MEASURED.

SET THE SLIDE SWITCH OF THE AC-DC PROBE TO "AC-OHMS" POSITION.

SET THE FUNCTION SWITCH TO "AC VOLTS RMS" POSITION.

SELECT THE DESIRED VOLTAGE RANGE ON THE RANGE SWITCH.

SHORT THE PROBE TIP TO ALLIGATOR CLIP AND ROTATE THE "ZERO ADJ." KNOB UNTIL THE METER POINTER COINCIDES WITH ZERO CALIBRATION ON THE BLACK "DC AND RMS" SCALE.

REMOVE SHORT AND READ AC RMS MEASUREMENTS ON THE BLACK "DC AND RMS" OR THE "1.2V RMS" SCALES AS FOLLOWS:

0 - 1.2V RMS, READ DIRECTLY ON THE SPECIAL "1.2V RMS" SCALE.

0 - 6V RMS, READ ON THE 60 SCALE, AND DIVIDE BY 10.

0 - 12V RMS, READ DIRECTLY ON THE 12 SCALE.

0 - 60V RMS, READ DIRECTLY ON THE 60 SCALE.

0 - 300V RMS, READ DIRECTLY ON THE 300 SCALE.

0 - 1200V RMS, READ ON THE 12 SCALE, AND MULTIPLY BY 100.

5. AC PEAK-TO-PEAK VOLTAGE MEASUREMENTS

THE HIGH INPUT IMPEDANCE PEAK-TO-PEAK DUO-DIODE CIRCUIT OF THE MODEL 98 IS FOLLOWED BY A SPECIAL MINIMUM-LOAD DIVIDER OUTPUT CIRCUIT. THIS OVERALL CIRCUIT PRODUCES VOLTAGE READINGS OF NARROW PULSE-TYPE WAVEFORMS WITH AN ACCURACY HERETOFORE UNOBTAINABLE IN COMMERCIAL VTVM'S. (A CALIBRATED OSCILLOSCOPE IS EVEN MORE ACCURATE, IN MEASURING PEAK-TO-PEAK VOLTAGES OF VERY NARROW PULSE, SLDW REPETITION RATE WAVEFORMS.)

SET THE SLIDE SWITCH ON THE AC-DC PROBE TO "AC-OHMS" POSITION.

SET THE FUNCTION SWITCH TO "AC VOLTS P-P."

SELECT THE DESIRED VOLTAGE RANGE ON THE RANGE SWITCH.

SHORT THE PROBE TIP AND ALLIGATOR CLIP TOGETHER, AND ROTATE THE "ZERO ADJ." KNOB UNTIL THE METER POINTER COINCIDES WITH THE LEFT-HAND ZERO CALIBRATIONS.

REMOVE THE SHORT AND READ AC PEAK-TO-PEAK MEASUREMENTS ON THE RED PEAK-TO-PEAK SCALES OR THE SPECIAL "3.2V P-P" SCALE, AS FOLLOWS:-

0 - 3.2V P-P, READ DIRECTLY ON THE SPECIAL "3.2V P-P" SCALE.

0 - 16V P-P, READ DIRECTLY ON THE 16V P-P SCALE.

0 - 32V P-P, READ DIRECTLY ON THE 32V P-P SCALE.

0 - 160V P-P, READ ON THE 16V P-P SCALE AND MULTIPLY BY 10.

0 - 800V P-P, READ DIRECTLY ON THE 800V P-P SCALE.

0 - 3200V P-P, READ ON THE 32V P-P SCALE AND MULTIPLY BY 100.

THE SPECIAL P-P CIRCUIT OF THE 98 CREATES A LONG TIME CONSTANT NETWORK WHICH LEADS TO A SLOW ZERO-RETURN OF THE METER POINTER AFTER A READING IS TAKEN. THE "P-P RESET" POSITION OF THE LINE SWITCH PERMITS THE OPERATOR TO RETURN THE POINTER TO ZERO MORE RAPIDLY, IF DESIRED, AFTER A MEASUREMENT IS MADE.

NOTE: IF THE LINE SWITCH IS HELD IN "P-P RESET" POSITION, THE METER POINTER MAY TRAVEL BELOW (TO THE LEFT) OF ZERO. THIS OCCURRENCE IS TO BE IGNORED INASMUCH AS THE POINTER RETURNS TO ITS PROPER POSITION WHEN THE SPRING RETURN "P-P RESET" SWITCH IS RELEASED.

6. HF PROBE TESTS

THE MODEL 98 VTVM, WHEN USED WITH ACCESSORY PRECISION MODEL RF-10A HIGH FREQUENCY PROBE BECOMES A GENERAL PURPOSE HIGH FREQUENCY VOLTMETER. THE BUILT-IN AC RMS FACILITIES OF THE 98 ARE USEFUL INTO AND BEYOND THE AUDIO SPECTRUM. THE RF-10A EXTENDS THE USEFULNESS OF THE 98 UP INTO THE VIDEO AND RADIO FREQUENCY SPECTRA.

NOTE: ALL VOLTAGE READINGS TAKEN WITH THE RF-10A PROBE ARE IN TERMS OF RMS OF SINUSOIDAL VOLTAGE.

TO USE THE RF-10A PROCEED AS FOLLOWS:

CONNECT THE RF-10A PROBE TO THE "HF PROBE" CONNECTOR OF THE 98 AND ALLOW THE USUAL 3 MINUTES WARM-UP PERIOD.

SET THE FUNCTION SWITCH TO "HF PROBE" POSITION.

SET THE RANGE SWITCH TO THE DESIRED VOLTAGE RANGE.

NOTE: DO NOT APPLY MORE THAN 300 VOLTS RMS TO THE RF-10A PROBE.

SHORT THE RF-10A PROBE TIP AND ALLIGATOR CLIP TOGETHER AND ROTATE THE "ZERO ADJ." KNOB UNTIL THE METER POINTER COINCIDES WITH THE ZERO ON THE BLACK "DC AND RMS" SCALE.

REMOVE THE TEMPORARY SHORT AND READ HF VOLTS ON THE BLACK "DC AND RMS", AND SPECIAL "1.2V RMS" SCALES AS FOLLOWS:-

0 - 1.2V RMS, READ DIRECTLY ON THE SPECIAL "1.2V RMS" SCALE.

0 - 6V RMS, READ ON 60 SCALE AND DIVIDE BY 10.

0 - 12V RMS, READ DIRECTLY ON 12 SCALE.

0 - 60V RMS, READ DIRECTLY ON 60 SCALE.

0 - 300V RMS, READ DIRECTLY ON 300 SCALE.

7. D.C. CURRENT

CAUTION: THE DC CURRENT FUNCTION IS NOT AN ELECTRONIC FUNCTION, I.E., IS NOT MEASURED THROUGH THE VACUUM TUBE BRIDGE CIRCUIT, BUT IS RELATED DIRECTLY TO THE INDICATING METER. THE METER IS THEREFORE QUITE SUSCEPTIBLE TO BURNOUT AND DAMAGE RESULTING FROM ACCIDENTAL CURRENT OVERLOADS. THEREFORE, WHEN MEASURING CURRENTS OR UNKNOWN VALUE IT IS ADVISABLE TO EMPLOY A HIGH CURRENT RANGE FIRST.

D.C. CURRENT MAY BE MEASURED WITH THE LINE SWITCH IN THE "OFF" OR "ON" POSITION, AS FOLLOWS:

INSERT ONE END OF THE RED AND BLACK TIP-JACK TEST LEADS INTO THE "+" AND "-" PIN JACKS.

SET THE FUNCTION SWITCH IN "DC CURRENT" POSITION.

SET THE RANGE SWITCH TO THE DESIRED CURRENT RANGE.

(GENERAL NOTE: A CURRENT-INDICATING METER OR INSTRUMENT IS ALWAYS CONNECTED IN SERIES WITH THE CIRCUIT IN WHICH THE MEASUREMENT IS TO BE MADE.)

PLACE THE OTHER END OF THE TEST LEADS IN SERIES WITH CIRCUIT BEING MEASURED.

READ D.C. CURRENT ON THE BLACK "DC AND RMS" SCALE AS FOLLOWS:-

0 - .3MA, READ ON 300 SCALE AND DIVIDE BY 1000.

0 - 1.2MA, READ ON 12 SCALE AND DIVIDE BY 10.

0 - 6MA, READ ON 60 SCALE AND DIVIDE BY 10.

0 - 30MA, READ ON 300 SCALE AND DIVIDE BY 10.

0 - 120MA, READ ON 12 SCALE AND MULTIPLY BY 10.

0 - 600MA, READ ON 60 SCALE AND MULTIPLY BY 10.

0 - 1.2AMPS, READ ON 12 SCALE AND DIVIDE BY 10

0 - 12AMPS, READ DIRECTLY ON 12 SCALE.

NOTE: BOTH THE 1.2 AMPS AND 12 AMPS RANGES ARE ONLY AVAILABLE THRU USE OF THE INDICATED SPECIAL JACKS TO THE RIGHT OF THE "(-)" AND "(+)" TIP JACKS. THE NEGATIVE TEST LEAD IS INSERTED INTO THE "(-)" JACK AND THE POSITIVE TEST LEAD INTO EITHER THE "1.2A" OR "12A" JACK AS DESIRED. THE RANGE SWITCH IS SET TO "600MA" POSITION WHEN THESE HIGH CURRENT JACKS ARE TO BE EMPLOYED.

CAUTION: WHEN USING THE "12A" RANGE, NEVER REMOVE THE TEST LEADS FROM THE PIN JACKS WHILE CURRENT IS FLOWING THROUGH THE CIRCUIT. FAILURE TO OBSERVE THIS CAUTION MAY RESULT IN ARCING AT THE PIN WHEN BEING REMOVED, AND THOUGH IT WOULD NOT INJURE THE METER, THE JACK MIGHT GRADUALLY CHAR.

8. DECIBEL METER

TWO DB SCALES ARE PROVIDED ON THE METER.

THE BOTTOM DB SCALE IS A SPECIAL LOW RANGE, COVERING FROM -20 TO +3 DB AND IS DIRECTLY RELATED ONLY TO THE "1.2V RMS" ARC. TO USE THIS LOW DB RANGE, SET THE MODEL 98 UP EXACTLY AS FOR THE "1.2V AC RMS" RANGE. READ DB VALUES DIRECTLY ON THIS BOTTOM DB ARC.

THE TOP DB SCALE RELATES TO ALL THE AC RMS RANGES ABOVE 1.2V RMS AND COVERS THE RANGES -10 TO +63 DB. THIS ARC WOULD USUALLY BE USED WHEN DB VALUES ABOVE THE VALUES OF THE LOW BOTTOM SCALE ARE TO BE ENCOUNTERED.

USE THIS TOP -10 TO +17 DB SCALE AS FOLLOWS:

RANGE SWITCH SETTING	ADD TO THE -10 TO +17 DB SCALE	DB RANGE BECOMES
6V	0	-10 to +17 Db
12V	+6	-4 to +23 Db
60V	+20	+10 to +37 Db
300V	+34	+24 to +51 Db
1200V	+46	+36 to +63 Db

NOTE: THE ABOVE DB READINGS ARE BASED ON A ZERO REFERENCE LEVEL OF ZERO DB = 1 MILLIWATT AT 600 OHMS OR .7746 VOLT ACROSS 600 OHMS. REFER TO DECIBEL CHART AT THE END OF THIS MANUAL FOR INTERPRETATION OF DB READINGS IN TERMS OF VOLTAGE RATIOS.

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CURRENT MEASUREMENTS OF LEAKAGE IN ELECTROLYTIC CONDENSERS

THE LEAKAGE IN AN ELECTROLYTIC IS MEASURED IN TERMS OF D.C. CURRENT (MA. PER MICROFARAD) FLOWING THROUGH THE CONDENSER, WHEN RATED D.C. VOLTAGE IS APPLIED.

ALL ELECTROLYTIC CONDENSERS CONTAIN AN INHERENT CURRENT LEAKAGE. HOWEVER, IF LEAKAGE ABOVE AN ALLOWABLE AMOUNT IS PRESENT, IT CAN THEN BE TERMED AS POOR. ALLOWABLE CURRENT LEAKAGE IS DEPENDENT UPON SUCH FACTORS AS AGE AND MANUFACTURERS' SPECIFICATIONS OF A CONDENSER, DESIGN OF POWER UNIT, FILTER SYSTEM AND RECTIFIER TUBE OF THE CIRCUIT IN WHICH THE CONDENSER IS INCORPORATED. IN GENERAL, CONSIDERING AN 8 MFD. CONDENSER THAT HAS BEEN IN USE (RATED AT 450 VOLTS) THE MAXIMUM ALLOWABLE LEAKAGE IS APPROXIMATELY .5 MA. PER MICROFARAD OR 4 MA. TOTAL.

THE FOLLOWING WILL SERVE AS A BASIS FOR COMPUTING APPROXIMATE ALLOWABLE LEAKAGES:

- A) FOR CONDENSER RATED AT 300 VOLTS OR MORE, LEAKAGE OF APPROXIMATELY .5 MA PER MICROFARAD IS PERMISSIBLE.
- B) FOR CONDENSERS RATED BETWEEN 100 TO 275 VOLTS, PERMISSIBLE LEAKAGE IS APPROXIMATELY .2 MA PER MICROFARAD.
- C) FOR CONDENSERS RATED BELOW 100 VOLTS, PERMISSIBLE LEAKAGE IS APPROXIMATELY .1 MA PER MICROFARAD.

CAUTION: WHEN OBTAINING ELECTROLYTIC LEAKAGE MEASUREMENTS, HIGH VOLTAGE IS EMPLOYED. IT IS THEREFORE EXTREMELY IMPORTANT THAT THE FOLLOWING INSTRUCTIONS BE ADHERED TO IMPLICITLY TO PREVENT DAMAGE TO METER.

PROCEDURE:

WITH CONDENSER DISCONNECTED FROM THE CIRCUIT, CHECK CONDENSER FOR SHORT WITH OHMMETER USING THE RX1K OHMS RANGE. POLARITIES MUST BE OBSERVED. THE ALLIGATOR CLIP OF THE AC-DC PROBE IS CONNECTED TO OUTSIDE CAN OR NEGATIVE TERMINAL OF CONDENSER AND THE TIP OF THE PROBE IS CONNECTED TO THE ANODE (POSITIVE) TERMINAL OF CONDENSER. A DECIDED LOW RESISTANCE READING OF THE OHMMETER INDICATES THAT THE CONDENSER IS SHORTED AND SHOULD BE REJECTED WITHOUT FURTHER TESTING.

WHEN AN ELECTROLYTIC INCORPORATED IN AN ACTUAL ITEM OF EQUIPMENT IS TO BE TESTED, THE NECESSARY RATED VOLTAGE IS AUTOMATICALLY APPLIED AND THE FOLLOWING CONNECTIONS ARE MADE FOR "FORMING" AND MEASURING THE CURRENT LEAKAGE, AFTER BEING (OHMMETER) TESTED FOR SHORT.

1. SET THE FUNCTION SELECTOR SWITCH TO "DC CURRENT" POSITION AND ROTATE THE "RANGE SELECTOR" TO THE "600 MA" POSITION.
2. REMOVE LEAD FROM (POSITIVE) ANODE TERMINAL OF CONDENSER AND CONNECT THIS LEAD TO THE POSITIVE (+) "MA" TIP JACK WITH A PROPER LIMITING RESISTOR IN SERIES. (WHERE VOLTAGE APPLIED TO CONDENSER IS ABOVE 100 VOLTS THE LIMITING RESISTOR SHOULD BE APPROXIMATELY 1000 OHMS. WHEN THE APPLIED VOLTAGE IS BELOW 100 VOLTS, THE VALUE OF THE LIMITING RESISTOR SHOULD BE APPROXIMATELY 300 OHMS. THIS LIMITING RESISTOR IS VERY IMPORTANT AND SHOULD NOT BE OMITTED.
3. CONNECT THE NEGATIVE (-) "MA" PIN JACK TO THE (POSITIVE) ANODE TERMINAL OF CONDENSER. (FROM THE ABOVE CONNECTIONS, IT CAN BE SEEN THAT THE "MA" TIP JACKS LIMITING RESISTOR, CONDENSER TERMINALS AND THE VOLTAGE SOURCE ARE IN SERIES CONNECTION.)
4. AFTER SERIES CONNECTIONS ARE MADE, TURN ON THE SWITCH OF THE SET OR CHASSIS BEING CHECKED. THE METER POINTER WILL NOW DEFLECT TO NEAR FULL SCALE AND THEN GRADUALLY REcede TO THE ZERO MARK OR NEAR ZERO, AFTER THE EXPIRATION OF ABOUT THREE MINUTES. THIS PROCEDURE IS KNOWN AS "FORMING" THE CONDENSER.

NOTE: A STEADY METER POINTER INDICATION WITHOUT RECEDING TO OR NEAR ZERO (AFTER FORMING PROCESS) INDICATES A SHORTED OR LEAKY ELECTROLYTIC AND SHOULD BE REJECTED WITHOUT FURTHER TESTING.

5. AFTER "FORMING", SHORT OUT THE LIMITING RESISTOR AND READ CURRENT LEAKAGE OF CONDENSER UNDER TEST DIRECTLY ON THE 120 MA SCALE. IF METER READING IS UNDER 30 MA, SET RANGE SELECTOR TO THE "30 MA" POSITION FOR A BETTER METER INDICATION AND READ ON 30 MA SCALE, ETC. (FOR COMPUTATION OF PERMISSIBLE CONDENSER LEAKAGE, REFER TO BASIS NOTED PREVIOUSLY.)

CAUTION: AFTER THIS TEST IS COMPLETED, ALWAYS FIRST DISCONNECT THE NEGATIVE TEST LEAD FROM CIRCUIT BEFORE TURNING OFF POWER SUPPLY TO PREVENT SLAMMING OF METER POINTER DUE TO DISCHARGE OF CONDENSER UNDER TEST.

TO TEST ELECTROLYTIC CONDENSERS NOT INCORPORATED IN A SET OR CHASSIS, AN EXTERNAL D.C. POWER SUPPLY IS NECESSARY, PREFERABLY ONE THAT EMPLOYS VARIOUS VOLTAGE TAPS SUITABLE TO APPLICATION FOR THE VARIOUS D.C. VOLTAGE CONDENSER RATINGS. IN THIS CASE, ADHERE TO THE SAME TESTING PROCEDURE AS NOTED ABOVE, IN PARAGRAPHS 1, 4 AND 5, BUT MAKING THE FOLLOWING SERIES CONNECTIONS:

- A) SELECT VOLTAGE TAP OF D.C. POWER SUPPLY APPROXIMATING THE RATED VOLTAGE OF CONDENSER TO BE TESTED.
- B) CONNECT POSITIVE POTENTIAL OF POWER SUPPLY TO THE POSITIVE (+) "MA" TIP JACK WITH A 1000 OHM LIMITING RESISTOR IN SERIES IF APPLIED POTENTIAL IS ABOVE 100 VOLTS. IF POTENTIAL IS 100 VOLTS OR UNDER, USE A 300 OHM LIMITING RESISTOR.
- C) CONNECT NEGATIVE POTENTIAL OF POWER SUPPLY TO OUTSIDE CAN OR NEGATIVE TERMINAL OF CONDENSER.
- D) CONNECT THE NEGATIVE (-) "MA" TIP JACK TO THE (POSITIVE) ANODE TERMINAL OF CONDENSER.
- E) REFER TO PARAGRAPHS 1, 4 AND 5, FOR OBTAINING CURRENT LEAKAGE MEASUREMENTS.

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5. QUALITATIVE PAPER CONDENSER TESTS: Using D.C. VTVM VOLTAGE RANGES.

THE INSULATION RESISTANCE OR PERMISSIBLE LEAKAGE OF PAPER AND MICA CONDENSERS IS EXPRESSED IN MEGOHM-MICROFARADS. A GOOD 1 MFD. CONDENSER WILL HAVE AN INSULATION OF APPROXIMATELY 450 MEGOHMS. FURTHERMORE, INSULATION RESISTANCE OF PAPER AND MICA CONDENSERS OF SIMILAR VOLTAGE RATINGS IS INVERSELY PROPORTIONAL TO ITS CAPACITY, SO THAT A GOOD .1 MFD CONDENSER WILL HAVE TEN TIMES THE INSULATION RESISTANCE OF A SIMILAR 1 MFD. CONDENSER, OR 4500 MEG-OHNS. IT THEREFORE CAN BE READILY SEEN THAT IT WOULD NOT BE ENTIRELY ACCURATE TO USE EVEN THE MODEL 98 HIGH RANGE OHMMETER FOR MEASURING LEAKAGES IN PAPER OR MICA CONDENSERS WHEN THE CAPACITY IS SMALLER THAN .1 MFD.

IN THE METHOD TO BE DESCRIBED, A HIGH D.C. POTENTIAL IS APPLIED TO THE CONDENSER IN SERIES WITH THE PROPER D.C. VOLTS RANGE TO DETERMINE WHETHER OR NOT IT HAS LOW INSULATION RESISTANCE OR ABNORMAL LEAKAGE.

THE NECESSARY D.C. POTENTIAL CAN BE OBTAINED FROM AN EXTERNAL HIGH VOLTAGE D.C. POWER SUPPLY OR FROM THE POWER OUTPUT TUBE SOCKET OF A RADIO RECEIVER. IN THE LATTER INSTANCE, THE PLATE PRONG POSITION OF THAT SOCKET WILL BE THE POSITIVE HIGH VOLTAGE LEAD, AND THE NEGATIVE RETURN OR GROUND WILL BE THE NEGATIVE LEAD. VOLTAGE TO BE APPLIED TO THE CONDENSER SHOULD NOT BE GREATER THAN ITS RATED VOLTAGE.

PROCEDURE:

1. MEASURE AND ADJUST THE D.C. VOLTAGE OBTAINABLE FROM D.C. POWER SUPPLY. THEN SELECT THE PROPER METER RANGE THAT WOULD INDICATE FULL SCALE DEFLECTION FOR THE VOLTAGE THERE AVAILABLE AND IN KEEPING WITH THE CONDENSER RATING.
2. WITH THE POWER SUPPLY OFF, INSERT THE CONDENSER TO BE TESTED IN SERIES WITH ONE OF THE TEST LEADS.
3. TURN ON POWER SUPPLY. AN INSTANTANEOUS DEFLECTION DUE TO THE CHARGE OF THE CONDENSER WILL BE INDICATED ON THE D.C. METER.
 - A) IN THE CASE OF A GOOD CONDENSER, THE NEEDLE POINTER WILL RECEDE TO (OR VERY CLOSE TO) THE ZERO VOLTAGE MARK.
 - B) IF THE METER POINTER REMAINS NOTICEABLY ABOVE THE ZERO MARK, THEN THIS INDICATES THAT THE CONDENSER HAS ABNORMAL LEAKAGE.
 - C) IF THE METER POINTER REMAINS AT THE INDICATED VALUE OF THE VOLTAGE MEASUREMENT OBTAINED PRIMARILY, THEN THE CONDENSER IS "SHORTED".
 - D) IF NO METER DEFLECTION IS OBTAINED, THEN THIS INDICATES THAT THE CONDENSER IS "OPEN" OR THAT THE CAPACITY IS TOO LOW IN VALUE TO INDICATE AN INSTANTANEOUS NOTICEABLE METER DEFLECTION WHEN CHARGED.

NOTE: AFTER THIS TEST IS COMPLETED, ALWAYS FIRST DISENGAGE THE NEGATIVE TEST LEAD FROM CIRCUIT BEFORE TURNING OFF POWER SUPPLY TO PREVENT SLAMMING OF NEEDLE POINTER DUE TO DISCHARGE OF CONDENSER UNDER TEST.

THIS METHOD OF USING A RELATIVELY HIGH D.C. POTENTIAL IN SERIES WITH A D.C. VTVM TO QUALITATIVELY CHECK PAPER CONDENSERS IS SUPERIOR TO A SIMPLE HIGH RANGE OHMMETER CHECK DUE TO THE FACT THAT THE HIGH POTENTIAL TENDS TO "SEARCH OUT" CONDENSER DEFECTS WHICH COULD CAUSE BREAKDOWN AT OPERATING POTENTIALS. THE LOW BATTERY VOLTAGE OF THE OHM-METER CIRCUIT (1.5 VOLTS) IS INSUFFICIENT TO PERFORM THE "SEARCHING" FUNCTION.

GENERAL INFORMATION

IN AN INSTRUMENT MANUAL OF THIS NATURE, IT IS INADVISABLE TO ATTEMPT TO COVER TOO MUCH GROUND, OTHER THAN THE BASIC OPERATION OF THE FACILITIES AVAILABLE. IN PRACTICE, THERE IS HARDLY A LIMIT TO THE NUMBER OF APPLICATIONS TO WHICH AN INSTRUMENT SUCH AS MODEL 98 MAY BE APPLIED, BOUNDED ONLY BY THE OPERATOR'S TECHNICAL TRAINING AND NECESSITIES. ACCORDINGLY, IT IS SUGGESTED THAT REFERENCE BE MADE TO ONE OR MORE OF MANY TEXTS AND TECHNICAL MAGAZINE ARTICLES ON THE APPLICATION AND USE OF VACUUM-TUBE-VOLTMETER, VACUUM-TUBE-OHMMETERS, ETC. SUCH ARTICLES PROVIDE DETAILED DATA AND CALCULATIONS (WHEN NECESSARY) FOR SUCH USEFUL MEASUREMENT SIMPLIFICATIONS AS "GUARD" TERMINALS FOR INSULATION LEAKAGE TESTS; APPLICATION OF D.C.-V.T.V.M.'S TO PEAK AND R.M.S. RADIO FREQUENCY MEASUREMENTS, MICROAMMETER MEASUREMENTS, ETC.

REGISTRATION CARD AND GUARANTEE CERTIFICATE ARE ENCLOSED WITH THIS INSTRUMENT. MAIL THE REGISTRATION CARD AT ONCE. THE PRECISION ONE YEAR WARRANTY CAN EXTEND ONLY TO DULY REGISTERED EQUIPMENT. ALWAYS GIVE MODEL AND SERIAL NUMBER WHEN WRITING FOR INFORMATION RELATIVE TO THIS INSTRUMENT.

MODEL 98 ACCESSORIES INCLUDED:

- 1 - AC-DC VTVM PROBE AND CABLE.
- 1 - SET #227 SUPER FLEX, GENERAL PURPOSE TEST LEADS.
- 1 - EVEREADY D-99 (OR EQUAL) $1\frac{1}{2}$ VOLT BATTERY.

ADDITIONAL ACCESSORIES AVAILABLE FOR THE MODEL 98:

- SERIES TV-8 HIGH VOLTAGE MULTIPLIER PROBE.
- SERIES RF-10A HIGH FREQUENCY PROBE.

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AN UNDERSTANDING OF "TEST SET ACCURACY"

THERE IS FREQUENT QUESTION AS TO THE MEANING OF STATEMENTS CONCERNING INSTRUMENT ACCURACY.

THE OVERALL ACCURACY OF A TEST INSTRUMENT IS USUALLY SPECIFIED AS THE ARITHMETIC SUM OF THE INDIVIDUAL CONTRIBUTING CIRCUIT COMPONENT TOLERANCES. THEREFORE, A $\pm 2\%$ METER IN CONJUNCTION WITH A $\pm 1\%$ MULTIPLIER PRODUCES AN INSTRUMENT OR TEST SET OF $\pm 3\%$ OVERALL TOLERANCE OR ACCURACY. SHOULD A VACUUM TUBE BE ALSO INCLUDED IN THE CIRCUIT, THE OVERALL CIRCUIT TOLERANCE IS THEN THAT OF THE METER PLUS MULTIPLIER PLUS VACUUM TUBE CIRCUIT.

CHANCE SELECTION OF METERS AND MULTIPLIERS CAN OCCASIONALLY PROVIDE COMBINATIONS WHICH MAY PRODUCE UNUSUALLY CLOSE OVERALL ACCURACY. THIS, HOWEVER, CANNOT BE SPECIFIED AS THE OVERALL TOLERANCE OF A PRODUCTION RUN, BECAUSE IT IS JUST AS POSSIBLE FOR COMPONENT COMBINATIONS TO RUN IN A NON-CANCELLING DIRECTION.

THE USUAL INTERPRETATION OF OVERALL ACCURACY, AS APPLIED TO ACTUAL METER SCALE-PLATE READINGS IS "THE SPECIFIED OVERALL TOLERANCE, AS OF FULL SCALE." THIS MEANS THAT IF A METER SCALE HAS 60 DIVISIONS, AND IF $\pm 3\%$ OVERALL ACCURACY IS SPECIFIED, THEN THE METER POINTER MAY PERMISSIBLY READ PLUS OR MINUS 1.8 DIVISIONS ($.03 \times 60$) OF TRUE VALUE, AT ANY POINT ON THE SCALE.

IN TERMS OF A VOLTAGE RANGE, (INSTEAD OF JUST DIVISIONS), LET US ASSUME A FULL SCALE VALUE OF 300 VOLTS. $\pm 3\%$ OF 300 VOLTS IS ± 9 VOLTS. THEREFORE, WHEN READING ON A 300 VOLT RANGE THERE IS A PERMISSIBLE ERROR OF PLUS OR MINUS 9 VOLTS. ON A 60 VOLT RANGE, THE ALLOWABLE ERROR WOULD BE PLUS OR MINUS 1.8 VOLTS, ETC.

SUCH PERMISSIBLE DEVIATIONS MUST BE TAKEN INTO CONSIDERATION WHEN MAKING COMPARATIVE READINGS BETWEEN TWO OR MORE INSTRUMENTS. THE OVERALL POTENTIAL READING ERRORS ARE CUMULATIVE. TWO UNITS, EACH OF $\pm 3\%$ OVERALL ACCURACY, MAY REVEAL A TOTAL READING DIFFERENTIAL OF 6% AS COMPARED TO EACH OTHER.

BECAUSE OF THE NON-LINEAR NATURE OF AN OHMMETER SCALE, TOLERANCE ON "OHMS SCALES IS RELATED TO LINEAR SCALE LENGTH AND NOT TO ACTUAL RESISTANCE READINGS. THEREFORE, CONCERNING OHMMETER RANGES, IF THE INSTRUMENT OVERALL TOLERANCE IS $\pm 3\%$, THE OHMMETER READING MAY VARY PLUS OR MINUS 3% OF THE TOTAL SCALE LENGTH, ON EITHER SIDE OF THE TRUE RESISTANCE VALUE.

FACTORS, SUCH AS TEMPERATURE, ALSO AFFECT OVERALL ACCURACY. THE METER ARMATURE, BEING COPPER-WOUND, IS QUITE SUSCEPTIBLE TO RESISTANCE CHANGES WITH TEMPERATURE. IN THE "PRECISION" 98, THE METER "COPPER" IS SWAMPED, TO MINIMIZE THIS SOURCE OF ERROR WHICH WOULD BE COMMON TO THE ENTIRE INSTRUMENT CIRCUIT.

THE MODEL 98 USES A RUGGED, DOUBLE-JEWELLED, DOUBLE-BRIDGE D'ARSONVAL TYPE PACE METER OF $\pm 2\%$ ACCURACY OR BETTER. ALL SHUNTS, CALIBRATING RESISTORS AND MULTIPLIERS ARE $\pm 1\%$ TOLERANCE OR BETTER. OVERALL DC INSTRUMENT ACCURACY IS ACCORDINGLY MAINTAINED WITHIN $\pm 3\%$; AC ACCURACY IS CLOSELY MAINTAINED WITHIN $\pm 5\%$.

THE FOREGOING IS ONLY A BRIEF RESUME ON THE SUBJECT OF INSTRUMENT ACCURACY. MORE DETAILED INFORMATION APPEARS IN MANY RADIO AND ELECTRICAL TEXTS AND JOURNALS, AS WELL AS IN "STANDARDS" LITERATURE PUBLISHED BY PROFESSIONAL ENGINEERING SOCIETIES SUCH AS AIEE, ASA AND IRE.

PRECISION APPARATUS COMPANY, INC.
70-31 84TH STREET,
GLENDALE 27, L.I., N.Y.
U.S.A.

DECIBEL CHART

NEG.			POS.			NEG.			POS.		
Voltage Ratio	Power Ratio	-Db+	Voltage Ratio	Power Ratio		Voltage Ratio	Power Ratio	-DB+	Voltage Ratio	Power Ratio	
1.0000	1.0000	0	1.000	1.000		.3162	.1000	10.0	3.162	10.000	
.9772	.9550	.2	1.023	1.047		.3090	.09550	10.2	3.236	10.47	
.9550	.9120	.4	1.047	1.096		.3020	.09120	10.4	3.311	10.96	
.9333	.8710	.6	1.072	1.148		.2951	.08710	10.6	3.388	11.48	
.9120	.8318	.8	1.096	1.202		.2884	.08318	10.8	3.467	12.02	
.8913	.7943	1.0	1.122	1.259		.2818	.07943	11.0	3.548	12.59	
.8710	.7586	1.2	1.148	1.318		.2754	.07586	11.2	3.631	13.18	
.8511	.7244	1.4	1.175	1.380		.2692	.07244	11.4	3.715	13.80	
.8318	.6918	1.6	1.202	1.445		.2630	.06918	11.6	3.802	14.45	
.8128	.6607	1.8	1.230	1.514		.2570	.06607	11.8	3.890	15.14	
.7943	.6310	2.0	1.259	1.585		.2512	.06310	12.0	3.981	15.85	
.7762	.6026	2.2	1.288	1.660		.2455	.06026	12.2	4.074	16.60	
.7586	.5754	2.4	1.318	1.738		.2399	.05754	12.4	4.169	17.38	
.7413	.5495	2.6	1.349	1.820		.2344	.05495	12.6	4.266	18.20	
.7244	.5248	2.8	1.380	1.905		.2291	.05248	12.8	4.365	19.05	
.7079	.5012	3.0	1.413	1.995		.2239	.05012	13.0	4.467	19.95	
.6918	.4786	3.2	1.445	2.089		.2188	.04786	13.2	4.571	20.89	
.6761	.4571	3.4	1.479	2.188		.2138	.04571	13.4	4.677	21.88	
.6607	.4365	3.6	1.514	2.291		.2089	.04365	13.6	4.786	22.91	
.6457	.4169	3.8	1.549	2.399		.2042	.04169	13.8	4.898	23.99	
.6310	.3981	4.0	1.585	2.512		.1995	.03981	14.0	5.012	25.12	
.6166	.3802	4.2	1.622	2.630		.1950	.03802	14.2	5.129	26.30	
.6026	.3631	4.4	1.660	2.754		.1905	.03631	14.4	5.248	27.54	
.5888	.3467	4.6	1.698	2.884		.1862	.03467	14.6	5.370	28.84	
.5754	.3311	4.8	1.738	3.020		.1820	.03311	14.8	5.495	30.20	
.5623	.3162	5.0	1.778	3.162		.1778	.03162	15.0	5.623	31.62	
.5495	.3020	5.2	1.820	3.311		.1738	.0320	15.2	5.754	33.11	
.5370	.2884	5.4	1.862	3.467		.1698	.02884	15.4	5.888	34.67	
.5248	.2754	5.6	1.905	3.631		.1660	.02754	15.6	6.026	36.31	
.5129	.2630	5.8	1.950	3.802		.1622	.02630	15.8	6.166	38.02	
.5012	.2512	6.0	1.995	3.981		.1585	.02512	16.0	6.310	39.81	
.4898	.2399	6.2	2.042	4.169		.1549	.02399	16.2	6.457	41.69	
.4786	.2291	6.4	2.089	4.365		.1514	.02291	16.4	6.607	43.65	
.4677	.2188	6.6	2.138	4.571		.1479	.02188	16.6	6.761	45.71	
.4571	.2089	6.8	2.188	4.786		.1445	.02089	16.8	6.918	47.86	
.4467	.1995	7.0	2.239	5.012		.1413	.01995	17.0	7.079	50.12	
.4365	.1905	7.2	2.291	5.248		.1380	.01905	17.2	7.244	52.48	
.4266	.1820	7.4	2.344	5.495		.1349	.01820	17.4	7.413	54.95	
.4169	.1738	7.6	2.399	5.754		.1318	.01738	17.6	7.586	57.54	
.4074	.1660	7.8	2.455	6.026		.1288	.01660	17.8	7.762	60.26	
.3981	.1585	8.0	2.512	6.310		.1259	.01585	18.0	7.943	63.10	
.3890	.1514	8.2	2.570	6.607		.1230	.01514	18.2	8.128	66.07	
.3802	.1445	8.4	2.630	6.918		.1202	.01445	18.4	8.318	69.18	
.3715	.1380	8.6	2.692	7.244		.1175	.01380	18.6	8.511	72.44	
.3631	.1318	8.8	2.754	7.586		.1148	.01318	18.8	8.710	75.86	
.3548	.1259	9.0	2.818	7.943		.1122	.01259	19.0	8.913	79.43	
.3467	.1202	9.2	2.884	8.318		.1096	.01202	19.2	9.120	83.18	
.3388	.1148	9.4	2.951	8.710		.1072	.01148	19.4	9.333	87.10	
.3311	.1096	9.6	3.020	9.120		.1047	.01096	19.6	9.550	91.20	
.3236	.1047	9.8	3.090	9.550		.1023	.01047	19.8	9.772	95.50	
						.1000	.01000	20.0	10.000	100.00	

VOLTAGE RATIOS BEYOND THE RANGE OF THE TABLES.

- A. Ratios less than those in tables: Multiply ratio by 10 successively until the result can be found in the tables. From the decibel value found from the table subtract +20Db for each time the multiple of 10 was used.

Example:- Voltage Ratio of 0.02042 - find Db value:-

$$.02042 \times 10 \times 10 = 2.042 \text{ from the table:- Voltage ratio of } 2.042 = 6.2 \text{ Db}$$

$$6.2 \text{ Db} - 20 \text{ Db} - 20 \text{ Db} = -33.8 \text{ Db.}$$

- B. Ratios greater than those in tables: Divide ratio by 10 successively until the result can be found in the tables. To the Db value found from the table add +20Db for each time the divisor of 10 was used.

Example:- Voltage Ratio of 407.4 - find Db value:-

$$407.4 \div 10 \div 10 = 4.074 \text{ from the table:- Voltage ratio of } 4.074 = 12.2 \text{ Db}$$

$$12.2 \text{ Db} + 20 \text{ Db} + 20 \text{ Db} = 52.2 \text{ Db.}$$

PRECISION APPARATUS COMPANY, INC.

70-31 84th STREET

GLENDAL 27, L. I., N. Y.

ITEM NO.	PART	SPECIFICATION
68	R53	250K Ω -P ZERO SET
67	R52	250K Ω -RMS ZERO SET
66	R51	1.2 MEG Ω -EACH
65	R50	9.1 MEG Ω -EACH
64	R49	560 Ω -EACH
63	R48	3500 Ω -OHMS ADJUST
62	R47	9K Ω -EACH METER CAL
61	R46	1200 Ω -EACH
60	R45	320 Ω -EACH
59	R44	60 Ω -EACH
58	R43	4.027 Ω -EACH
57	R42	1.073 Ω -EACH
56	R41	0.134 Ω -EACH
55	R40	0.1208 Ω -EACH
54	R39	0.0134 Ω -EACH
53	R38	2.2K Ω -EACH
52	R37	2.2 MEG Ω -EACH
51	R36	2.2K Ω -EACH
50	R35	82K Ω -EACH
49	R34	10K Ω -ZERO ADJUST
48	R33	1.5 MEG Ω -EACH
47	R32	575K Ω -EACH
46	R31	3.37 MEG Ω -EACH
45	R30	3.09 MEG Ω -EACH
44	R29	46.4K Ω -EACH
43	R28	158K Ω -EACH
42	R27	1.248 MEG Ω -EACH
41	R26	12K Ω -EACH
40	R25	36K Ω -EACH
39	R24	192K Ω -EACH
38	R23	960K Ω -EACH
37	R22	1.2 MEG Ω -EACH
36	R21	9.6 MEG Ω -EACH
35	R20	10 MEG Ω -EACH
34	R19	1 MEG Ω -EACH
33	R18	100K Ω -EACH
32	R17	10K Ω -EACH
31	R16	1K Ω -EACH
30	R15	9.8 Ω -EACH
29	R14	2.200 Ω -EACH
28	R13	15K Ω -EACH
27	R12	68K Ω -EACH
26	R11	56K Ω -EACH
25	R10	72 MEG Ω -EACH
24	R9	12 MEG Ω -EACH
23	R8	47K Ω -EACH
22	R7	6 MEG Ω -EACH
21	R6	214K Ω -EACH
20	R5	9100 Ω -EACH
19	R4	13.33 MEG Ω -EACH
18	R3	3.8 MEG Ω -EACH
17	R2	800K Ω -EACH
16	R1	1.33 MEG Ω -EACH
15	T1	POWER TRANSFORMER
14	P1	N247 PILOT LAMP
13	N1	NEON LAMP
12	M1	200 μ METER
11	SW1	OHMS CHECK-P-P RESET
10	RS(10)	RANGE SELECTOR SW.
9	FS(10)	FUNCTION SWITCH
8	C7	0.1 MFD. EACH
7	C6	10 MFD.
6	C5	4.7 MMFD.
5	C4	0.05 MFD. EACH
4	C3	470 MMFD.
3	C2	10 MFD.
2	C1	0.1 MFD.
1	B1	1.5V. BATTERY

PRECISION APPARATUS Co. INC.
GLENDAL 27 L.I., N.Y.

TITLE: MODEL 98 SCHEMATIC
V.T.V.M.

DRAWN BY: M. KRAMER DATE: 4-26-55
CHECKED BY: M. KRAMER DATE: 4-29-55

